

MULTI-POSITIONAL SWITCH FOR AIRCRAFT

BACKGROUND OF THE INVENTION

The present invention pertains to a multi-positional switch for the controls of an aircraft, and, more particularly, pertains to a multi-positional electrical switch for providing tactile feedback to the operator of the various switch positions.

Switches, such as push button and toggle switches, are found in everything from cameras and computer keyboards, power tools and home appliances, automotive vehicles and industrial machinery. For the above uses, as well as numerous other uses, the operator has the opportunity and time to visually observe the position of the various operational and control switches at any moment in order to confirm the particular state, engaged or disengaged, of the switch, and to obtain assurance in the form of immediate visual feedback that the switch or switches are in their proper position.

However, in certain work environments it may not be possible or desirable for the user or operator to carefully view and inspect the particular position of the switch due to safety and operational requirements. One example of such a work environment is in the operation and control of aircraft where the pilot, co-pilot or navigator must maintain constant vigilance in order to avoid even the slightest distraction that could lead to a fatal error and a devastating accident. Many of the switches used in aircraft are multi-contact switches wherein accuracy and stability are prerequisites for proper functioning in order for the operator to easily and accurately determine the state the particular switch is in.

In general a five-way switch is utilized as the conventional type of switch for aircraft. Such conventional five-way switches are configured to allow the operator to instantly sense and perceive the act and condition of switching through the perception of sounds produced by the switch contacts. However, an acute drawback in the

perception of such sounds at the actual moment of switching is that the intense noise in the cockpit, combined with the fact that the operators are often wearing headsets, thoroughly obstructs the distinct perception of the switching sounds. Therefore, it is necessary for the flight operators to reliably sense the individual switching states solely through the tactile sense.

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Thus, a number of switches have been conceived for providing a tactile and/or audible sense or feeling to the operator or user of the equipment. The Harris patent (U.S. patent 4,466,302), the Wu et al. patent (U.S. patent 4,939,327), and the Skulic patent (U.S. patent 5,057,657) all disclose keyboard switches. Harris discloses a switch actuation mechanism utilizing a stem for contacting cammed surfaces that in turn engage a rocking plate member for initiating electrical energization while Wu et al. utilizes a reciprocable plunger that actuates a leaf spring and an actuating arm for producing a tactile sense and Skulic discloses a switch actuator mechanism utilizing a cooperating plunger and slide member to create the tactile sense or feeling.

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The Naimer patent (U.S. patent 3,539,736) discloses a switch having a reciprocable shaft with cam elements adjoined thereto, and the cam elements actuating independently shiftable armatures.

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The Roeser patent (U.S. patent 3,772,484) discloses a dual action electrical switch wherein an actuator engages a pair of pivotally mounted switch levers for engaging the dual action switch.

The Metzler patent (U.S. patent 5,907,138) discloses a push-button switch having a reciprocable rod that successively engages spring biased stops each of which corresponds to an electrical contact for initiating electrical conduction.

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The Hoskins patent (U.S. patent 5,945,647) discloses an electrical control apparatus having a control member that can establish an electrical circuit by either rotary or axial motion.

Nonetheless, despite the ingenuity of the above devices, there remains a need for a multi-positional switch that provides reliable, accurate, and immediate tactile feedback to the operator regarding the various switch positions to which the switch has been shifted or toggled.

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SUMMARY OF THE INVENTION

The present invention comprehends a multi-positional electrical switch for use in aircraft in order to provide an immediate tactile sensation and tactile feedback to the operator regarding the various switching positions to which the switch has been moved.

10 The present invention includes a generally cylindrical housing having a manually displaceable push button mounted at the upper end of the housing. Projecting out of the lower end of the housing can be one or more radially disposed terminals and a central terminal. In addition, auxiliary contacts are adjoined to the terminals, and each auxiliary contact includes a bent portion adjacent a drive stem when the drive stem is in a non-actuated state. Secured to the push button and located at the upper end of the housing therein is a deformable cap. A guide shaft is axially mounted to the cap and includes a bore for receiving therein the drive stem that can be actuated for linear, slidable reciprocable movement and radial motion within the housing by operation of the push button. A pair of sleeves is disposed within the housing for delimiting the range of axial and radial motions of the guide shaft and drive stem. An L-shaped common terminal member is disposed adjacent the lower end of the housing and includes a rectilinear portion extending outwardly from the end of the housing and a circular portion disposed within the housing and below the guide shaft. The circular portion includes an aperture through which the drive stem can extend. Confined between an interior flange of the guide shaft and the circular portion of the common terminal member is a compression spring.

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Closing off the lower end of the housing is a lower enclosure plate, and the lower enclosure plate supports the central terminal. The central terminal protrudes outwardly from the lower enclosure plate and is in general axial alignment with the drive stem when the push button is in the non-operational state. Disposed within the housing and supported on the lower enclosure plate is a toggle or shifting plate. The toggle plate also has an aperture through which the drive stem can extend when the push button is actuated. Located immediately below the toggle plate is a spring-mounted resistance pin for offering resistance to the drive stem as the drive stem passes through the aperture of the toggle plate for contacting the central terminal.

By manipulating the push button the operator can move the drive stem against the toggle plate in a radial direction so that the drive stem contacts the auxiliary contacts for electrical energization and switching. When the operator applies a downward force in the axial direction, the drive stem is forced through the aperture of the toggle plate contacting and overcoming the resistance of the resistance pin, which the operator perceives by through the tactile sense alone. Further downward pressure by the operator's finger applied to the push button causes the drive stem to contact the central terminal.

It is an objective of the present invention to provide a multi-positional switch that provides an easy and immediate perception to the operator of the particular switching state of the switch through tactile sensation alone.

It is another objective of the present invention to provide a multi-positional switch which can be moved and toggled in both axial and radial directions and which conveys the tactile sense to the operator when external pressure exceeds a predetermined limit is applied to the switch.

These and other objects, features, and advantages will become apparent to one skilled in the art upon a perusal of the following detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter of the invention, it is believed the invention will be better understood from the following description, taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a perspective view of a multi-positional switch of the present invention;

Figure 2 is a sectional view of the multi-positional switch first shown in Figure 1;

Figure 3a is a portion of a view of Figure 3b enlarged for magnification purposes of a drive stem of the multi-positional switch first shown in Figure 1;

Figure 3b is sectional view of the multi-positional switch to be toggled for engaging a radially disposed contact terminal;

Figure 4a is a portion of a view of Figure 4b enlarged for magnification purposes of the drive stem toggled against a toggle plate;

Figure 4b is a sectional view of the multi-positional switch toggled against the toggle plate;

Figure 5a is a portion of a view of Figure 5b enlarged for magnification purposes showing the toggling of the drive stem over the toggle plate;

Figure 5b is a sectional view of the multi-positional switch toggling over the toggle plate;

Figure 6a is a portion of a view of Figure 6b enlarged for magnification purposes showing the engagement of the drive stem against a bent portion of one auxiliary contact;

Figure 6b is a sectional view of the multi-positional switch contacting the bent portion of the auxiliary contact;

Figure 7a is a portion of a view of Figure 7b enlarged for magnification purposes showing the drive stem as the drive stem is positioned for engaging a central terminal;

5 Figure 7b is a sectional view of the multi-positional switch;

Figure 8a is a portion of a view of Figure 8b enlarged for magnification purposes showing the drive stem as the drive stem passes through an aperture of the toggle plate;

Figure 8b is a sectional view of the multi-positional switch passing through the aperture of the toggle plate;

10 Figure 9a is a portion of a view of Figure 9b enlarged for magnification purposes showing the drive stem as the drive stem encounters resistance from a resistance pin during downward travel of the drive stem;

Figure 9b is a sectional view of the multi-positional switch contacting the resistance pin;

15 Figure 10a is a portion of a view of Figure 10b enlarged for magnification purposes showing the drive stem in engagement with the central contact terminal; and

Figure 10b is a sectional view of the multi-positional switch contacting the central contact terminal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

20 Illustrated in Figures 1 – 10 is a multi-positional switch 10 for aircraft that provides the operator with immediate feedback on the particular switching state of the switch by means of tactile sensations in the form of touch sensing of the switch 10. The present invention is a 5-way switch that conveys immediate tactile sensations to the operator when the operator applies a given pressure to the switch 10.

25 The multi-positional switch 10 of the present invention, as shown in Figures 1 and 2, includes a cylindrical casing or housing 12 having an upper end 14 and an

opposite lower end 16. The housing 12 also includes an interior chamber that extends from the upper end 14 to the lower end 16 for containing structural elements hereinafter further described. Mounted at the upper end 14 of the housing 12 is a push button 18 for selective depression and release by the operator for engagement to and disengagement from various switching positions in order to achieve electrical sensitivity and connection with other mechanical and/or electrical elements for operating the aircraft. Secured to the lower end 16 of the housing 12 is a lower enclosure plate 20, and the lower enclosure plate 20 includes a plurality of slots or channels radially arranged about a central opening 22 that extends through the lower enclosure plate 20. Disposed inboard of the lower enclosure plate 20, and contiguous thereto, is support housing 24. The support housing 24 includes a support housing opening 26 that is axially aligned with the central opening 22 of the lower enclosure plate 20. A blind hole 28 is formed in the body of the support housing 24 and extends inward and perpendicular to the support-housing opening 26. Located within the blind hole 28 is a resistance pin compression spring 30 and a resistance pin 32, both of which will be hereinafter described. The resistance pin 32 is capable of linear reciprocable movement therein and can extend partially into the support housing opening 26 of the support housing 24 when in its non-engaged disposition. The interior annular wall of the blind hole 28 also includes a stopping ledge or sill 34 that delimits the range of linear movement of the resistance pin 32.

As shown in Figures 1 – 10, a common central terminal 36 is mounted to the central opening 22 of the lower enclosure plate 20 and partially projects therefrom external to the housing 12. In addition, one or more terminals 38 are mounted to the lower enclosure plate 20 and the support housing 24. The terminals 38 extend through aligned channels or slots of the lower enclosure plate 20 and the support housing 24 within the chamber of the housing 12 and the terminals 38 also protrude exterior to the housing 12 for making electrical contact with other electrical circuitry

and elements for aircraft operation. The terminals 38 are radially arranged about the central terminal 36. In addition, an L-shaped common terminal member 40 that may serve as the ground is mounted to the lower enclosure plate 20 and the support housing 24. The common terminal member 40 includes an annular portion 42 that is disposed within the chamber of the housing 12 and a rectilinear portion 44 extending downwardly through the lower enclosure plate 20 and externally from the lower end 16 of the housing 12. The annular portion 42 further defines an aperture 46 that is disposed in axial alignment with the common central terminal 36.

Illustrated in Figures 2 – 10 is a switching or toggle plate 48 mounted on the support housing 24 and in axial alignment with the support housing 24 and the central terminal 36 that is secured to the lower enclosure plate 20. The toggle plate 48 includes a toggle plate surface 49, a toggle plate aperture 50, and a toggle plate entry chamfer 51. The toggle plate aperture 50 is axially aligned with the central terminal 36. Adjoined to and in electrical contact with the portion of the terminals 38 that project within the chamber of the housing 12 adjacent the toggle plate 48 are a plurality of auxiliary contacts 52. One auxiliary contact 52 is adjoined to each terminal 38. Each auxiliary contact 52 has an interior pliable bent or angled portion 54 that is capable of being brought into contact with the inner portion of the respective terminal 38 to which it is adjoined. The angled portion 54 of each auxiliary contact 52 is pliable; the non-engaged state is shown in Figures 2- 4 and the electrically engaged state is shown in Figures 5 and 6.

As shown in Figure 2, the switch 10 includes a pair of annular interior sleeves that abut the inside surface of the housing 12 for supporting structural elements hereinafter further described. Specifically, the sleeves include a guide shaft mounting sleeve 56 and a terminal support sleeve 58. The sleeves 56 and 58 are axially aligned with each other, and the terminal support sleeve 58 abuts the circular portion 42 of the common terminal member 40. The guide shaft mounting sleeve 56

includes an inner annular protrusion 60 that is further defined by an interior annular ledge 62.

As shown in Figure 2, the push button 18 includes an interior boss 64 that has an inner cavity or recess 66 formed therein. Mounted to the inner cavity 66 of the boss 64 is a flexible and slightly deformable cap 68. The cap 68 is deformable and pliable to permit toggling of the push button 18 by the operator in both the axial and radial directions. The cap 68 includes a stem portion 70 and a disc portion 72 integrally formed to the stem portion 70. The rim of the disc portion 72 rests within an outer annular channel of the guide shaft mounting sleeve 56. The stem portion 70 also includes an interior stem bore 74 and a stopper 76 is placed within the bore 74 at the location where the bore 74 registers with the interior cavity 66 of the push button 18. Also disposed within the interior stem bore 74 is a drive stem compression spring 78, and, as shown in Figure 2, one end of the drive stem compression spring 78 is seated on the stopper 76.

With reference to Figure 2, adjoined to the stem portion 70 of the pliable cap 68 is a guide shaft 80. The guide shaft 80 includes an annular portion 82 having an interior flange 84 and a tapered or conical portion. When the guide shaft 80 is in the non-engaged state, the annular portion 82 abuts the interior ledge 62 of the guide shaft mounting sleeve 56. The guide shaft 80 further includes an inner passageway 86 that is in axial alignment with the annular bore 74 of the stem portion 70 of the cap 68 as shown in Figure 2. Although the cap 68 and guide shaft 80 are two separate elements in the preferred embodiment, it is readily conceivable that the guide shaft 80 and the cap 68 could be manufactured as a unitary component and function in the same manner as the embodiment herein disclosed.

As shown in Figures 2 – 10, a drive shaft or stem 88 is disposed within the bore 74 of the cap 68 and the inner passageway 86 of the guide shaft 80. The drive stem 88 is seated on one end of the drive stem compression spring 78 and travels

downward toward the toggle plate 48 when the push button 18 is depressed for engaging the terminals 38 or the central contact terminal 36. In order to limit downward movement, the drive stem 88 includes a stopping sill or neck 90 that contacts the annular wall of the passageway 86 of the guide shaft 80. The outside diameter of the drive stem 88 is sized so that the drive stem 88 can slide through the aperture 46 of the common terminal member 40 and the opening 26 of the support housing 24 for engaging the central contact terminal 36 as illustrated in Figures 7 – 5 10. Thus, the drive stem 88 is capable of selective linear reciprocable movement within the guide shaft sleeve 56 and the terminal support sleeve 58 concomitant with and actuated by the depression and toggling of the push button 18 to attain the various switching positions. The drive stem 88 includes a recess 89 into which the resistance pin 32 may seat. The drive stem 88 also includes a curved or rounded end 94, which contacts a curved or rounded end 96 of the resistance pin or sliding plate 32 for facilitating the forcing of the resistance pin 32 by the drive stem 88 back into the hole 28.

A primary or main compression spring 92 is disposed within the housing 12 and encompassed by the guide shaft mounting sleeve 56 and the terminal support sleeve 58. The primary compression spring 92 is disposed circumjacent the drive stem 88 with a first end of the primary spring 92 abutting the interior flange 84 of the guide shaft 80 and an opposite second end seated on the annular portion 42 of the common terminal member 40.

The number of contact terminals 38 and 36 may be varied for providing a switch having multiple switching positions. For example, one centrally disposed contact terminal 36 would provide 1-way switching. Two radially disposed contact terminals 38 positioned to the right and left of the centerline of the switch would provide 2-way switching. Four radially disposed contact terminals 38 installed right and left and back and front of the centerline of the switch would provide 4-way

switching possible. One axially disposed contact terminal 36 and two radially disposed contact terminals 38 would provide 3-way switching, and one axially disposed contact terminal 36 and four radially disposed contact terminals 38 would provide 5-way switching. Any other desirable combination of contact terminals may 5 be used to provide the desired number of switching positions.

With reference to Figures 3 - 6, the operation of the push button 18 for toggling in a radial manner to bring the drive stem 88 in engagement with the toggle plate 48 and then in engagement with the auxiliary contacts 52 and the terminals 38 will first be described. If the operator depresses the push button 18 in a radial 10 direction, the cap 68 slightly deforms to allow the concomitant angled or rotational movement of the guide shaft 80 and drive stem 88. The rounded end of the drive stem 88 initially comes in contact with the toggle plate 48 as shown in Figure 4. Continued depression of the push button 18 is impeded but the operator, by maintaining pressure on the push button 18, causes the drive stem 80 to overcome the 15 force of the primary spring 92 and thus the drive stem 88 continues to travel on the surface of the toggle plate 48 as shown in Figures 3 and 4. The additional pressure on the push button 18 can be easily sensed by the operator as an immediate tactile sensation conveyed by the operator's fingers.

As shown in Figure 5, the continued movement of the drive stem 88 along the 20 surface of the toggle plate 48 causes the drive stem 88 to contact the angled portion 54 of one auxiliary contact 52 adjoined to that respective terminal 38. The force applied by the drive stem 88 causes the drive stem 88 to bend the angled portion 54 back against the auxiliary contact 52. Since each contact 52 is connected to one respective terminal 38 for electrical sensing and conduction, the drive stem 88 becomes electrically sensitive with that respective terminal 38 upon attaining the 25 position illustrated in Figure 6. By continuously pressing the push button 18 the drive stem 88 is maintained in the state shown in Figure 6 and thus a very stable electrical

sensitivity is achieved. With the terminals 38 arranged about the common central terminal 36 as shown in Figure 1, the present invention provides for a five position switch. The aforescribed actions would be repeated were the operator to toggle the push button 18 and guide shaft 80 in order to bring the drive stem 88 into contact with any of the other terminals 38. When the force of the drive stem 88 against the bent portion 54 of the auxiliary contact 52 is released, the bent portion 54 returns to the angled disengaged state as shown in Figures 3 and 4.

With reference to Figures 7 – 10, the actions that bring the drive stem 88 into electrical engagement with the common central terminal 36 will now be described. In the standard position the drive stem 88 will be in axial alignment with the aperture 50 of the toggle plate 48, the opening 26 of the support housing 24 and the common central terminal 36. When the operator depresses the push button 18 in the linear downward direction the drive stem 88 passes through the aperture 50 of the toggle plate 48. The continued downward travel of the drive stem 88 is initially hindered by the resistance pin 32 that juts into the opening 26 of the support housing 24. As the drive stem 88 travels downward the primary spring 92 is further compressed thereby increasing the potential elastic restorative force inherent in the primary spring 92. When the restoring force of the primary spring 92 exceeds the resistive force of the resistance pin 32 resulting from the extension of the compression spring 30 within the hole 28, the downwardly directed force of the drive stem 88 is able to force the resistance pin 32 back into the hole 28 as shown in Figures 8 and 9. The drive stem 88 then proceeds downward past the resistance pin 32 with the assistance of the primary spring 92 until the end of the drive stem 88 comes into contact with the common central terminal 36.

As shown Figures 9 and 10, the operator continues depressing the push button 18 thereby maintaining the downwardly directed force on the drive stem 88 which forces the resistance pin 32 to slide back into the hole 28 thus allowing the drive stem

88 to pass thereby. Once the resistance pin 32 has been forced to withdraw from the support opening 26, the drive stem 88 will continue to proceed downward but now through the application of less force and with the assistance of the accumulated restoring force of the spring 92. Figure 10 illustrates the furthest downward position of the drive stem 88 wherein the drive stem 88 is disposed in electrical connection to the common terminal member 40. The operator can easily and quickly perceive the state of being switched by the significant decrease in the applied force as the drive stem 88 travels past and clears the resistance pin 32 for electrical engagement with the common terminal member 40. The drive stem 88 and the guide shaft 80 return to their disengaged state by the relaxation of the primary spring 92 upon the operator releasing his or her finger from the push button 18.

The foregoing description discloses and describes a preferred embodiment for the invention, and those skilled in the art will understand that other variations and modifications may be possible and practicable, and still come within the ambit of the invention.